The airborne LUnar Spectral Irradiance (air-LUSI) Mission

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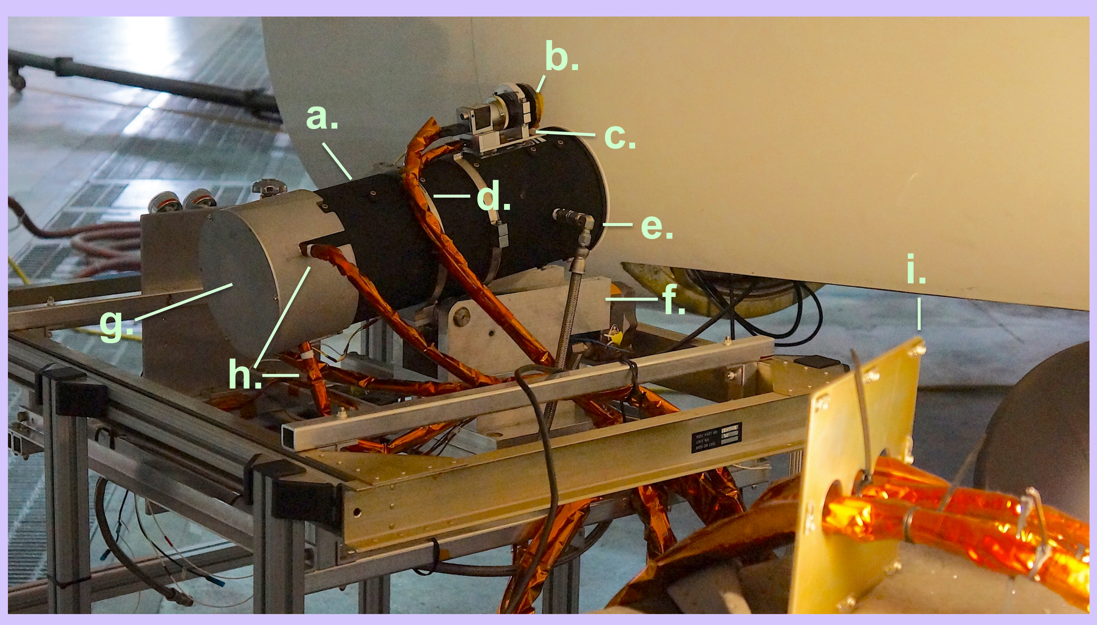
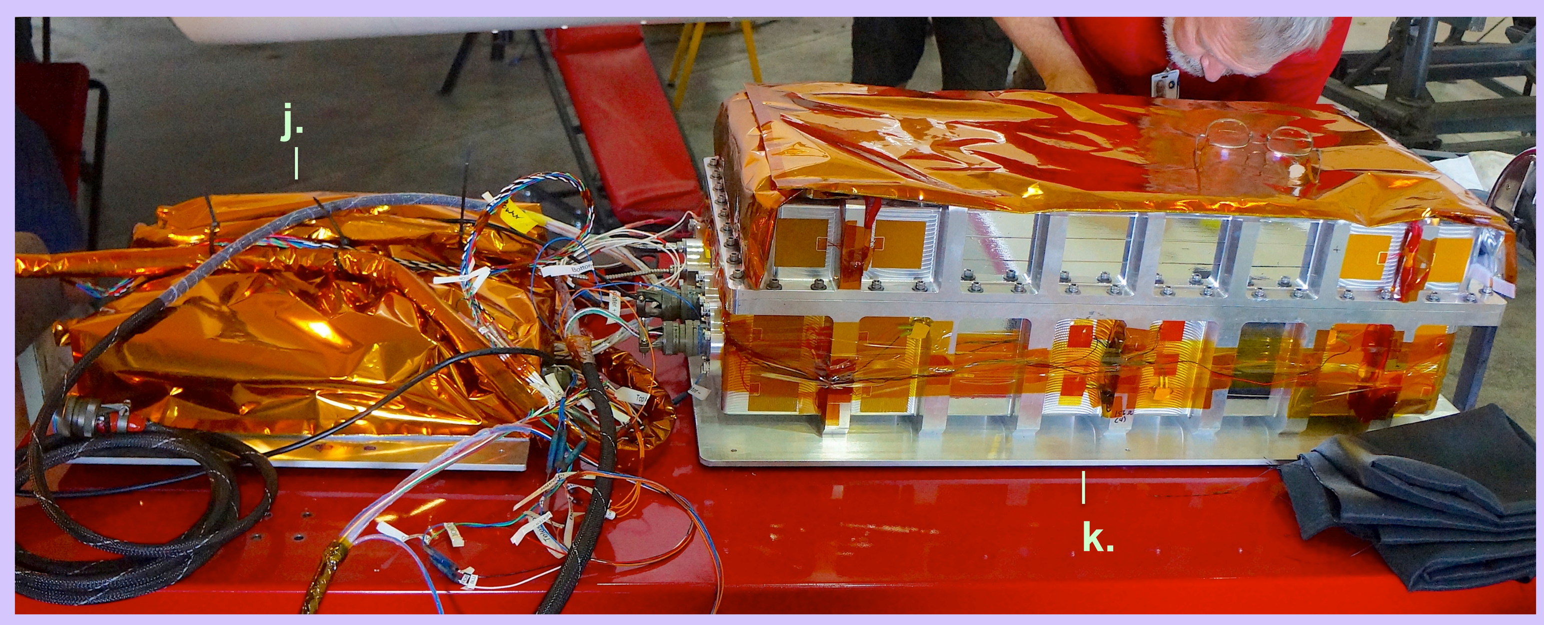
1. OVERVIEW

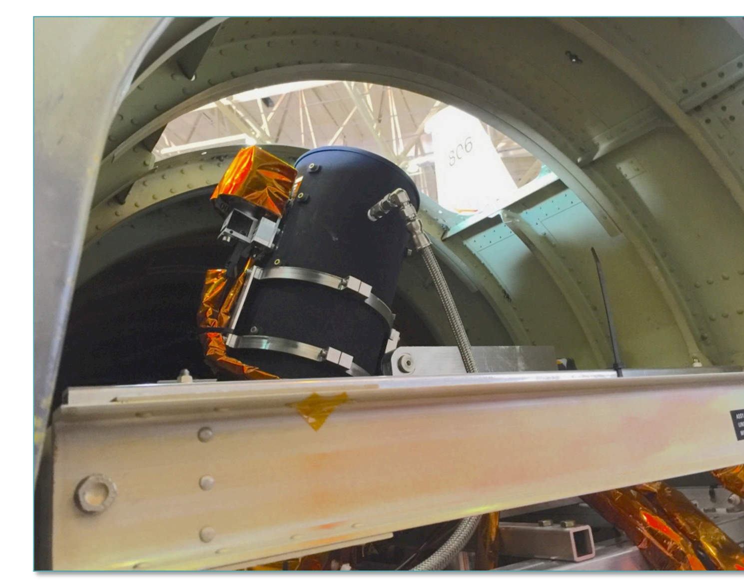
The airborne LUnar Spectral Irradiance (air-LUSI) mission is a NASA Airborne Instrument Technology Transition (AITT) project. The goal of the AITT program is to mature airborne instruments from the demonstration phase to science-capable instruments.

The USGS RObotic Lunar Observatory (ROLO) model represents the most precise knowledge of lunar spectral irradiance and is used frequently as a relative calibration standard for Earth observation by space-borne sensors (Keiffer and Stone, 2005). However, apparent phase-dependent biases in ROLO limits its application for absolute radiometric calibration.

The objective of air-LUSI is to provide NASA a capability to improve ROLO by measuring exo-atmospheric lunar spectral irradiance with unprecedented accuracy. Careful characterization of the Moon from above the atmosphere will make it a stable and consistent SI-traceable absolute calibration reference. This could revolutionize lunar calibration for some Earth observing satellites and would be especially beneficial to ocean color missions. Because of the high sensitivity of aquatic remote sensing to calibration (Turpie et al., 2015), improvement of lunar calibration could directly affect upcoming **PACE** and JPSS (**VIIRS**) missions, and retrospectively for the **SeaWiFS**, EOS (MODIS), and S-NPP (**VIIRS**) data records.





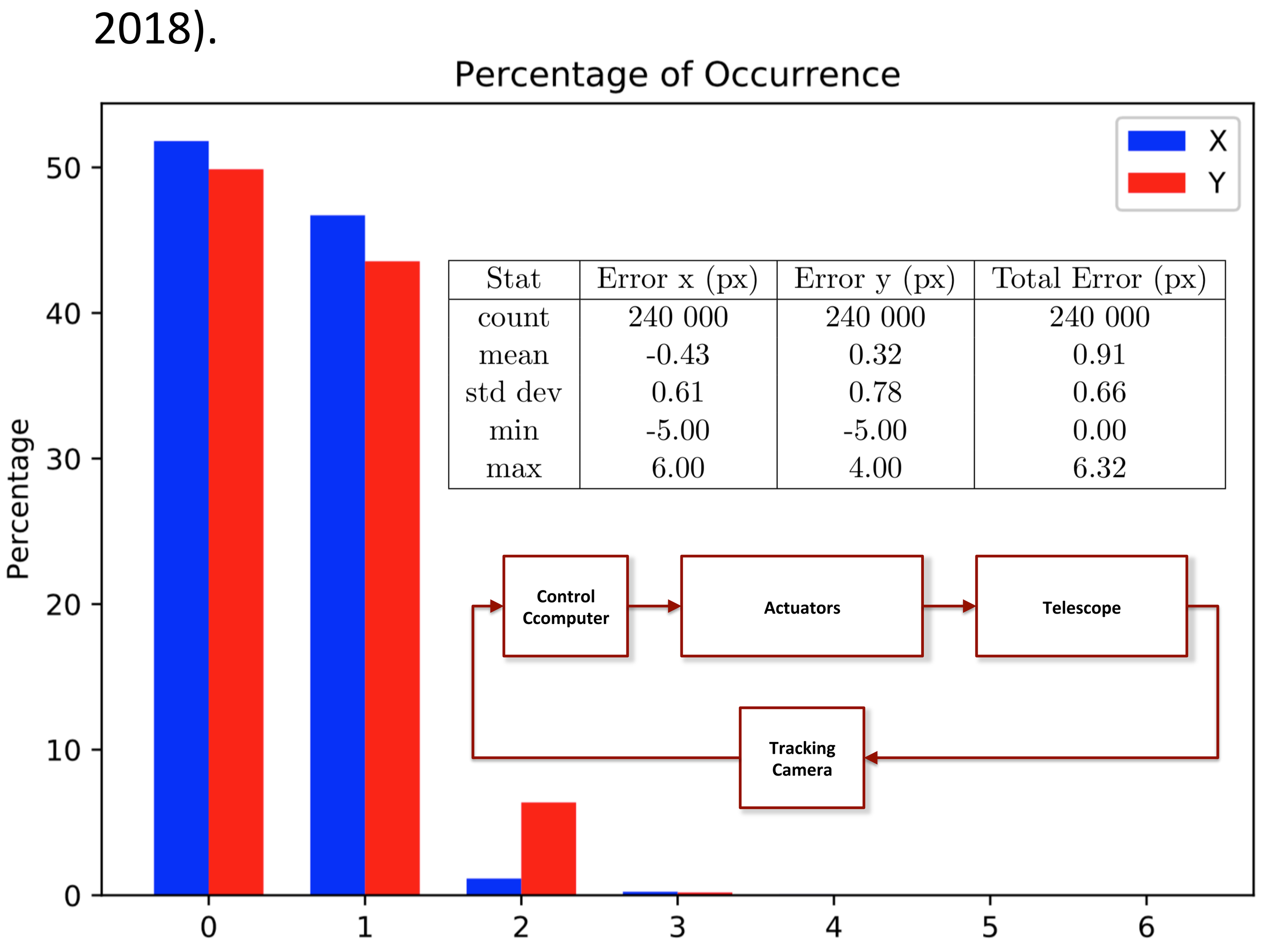


Situated in the ER-2 wing pod, the IRIS telescope sits on the ARTEMIS.

a. telescope
b. tracking camera (TC)
c. IMU
d. insulated cables
e. NO_2 purge line
f. mount yoke w/ actuators
g. back cover with integrating sphere
h. umbilical with fiber optics
i. bulkhead panel with ARTEMIS and IRIS umbilicals
j. ARTEMIS computer assembly
k. IRIS instrument enclosure

2. DESIGN

Building on the mountain-based work of Cramer et al. (2013), air-LUSI approaches this characterization by taking lunar spectral irradiance measurements at high-altitude on the ER-2 aircraft. This is accomplished with a non-imaging telescope to collect moonlight, which is passed to a NIST-calibrated spectrometer (called the Irradiance Instrument Subsystem or IRIS) via fiber optics. The spectrometer and an on-board validation reference are hermetically sealed in an enclosure made of a two solid blocks of aluminum, keeping the spectrometer and reference at constant sea-level pressure and 20°C during the high altitude flight. The Autonomous, Robotic TElescope Mount Instrument Subsystem (ARTEMIS) keeps the telescope pointed at the Moon using a camera to track the sky in front of the telescope (Cataford et al., 2018).



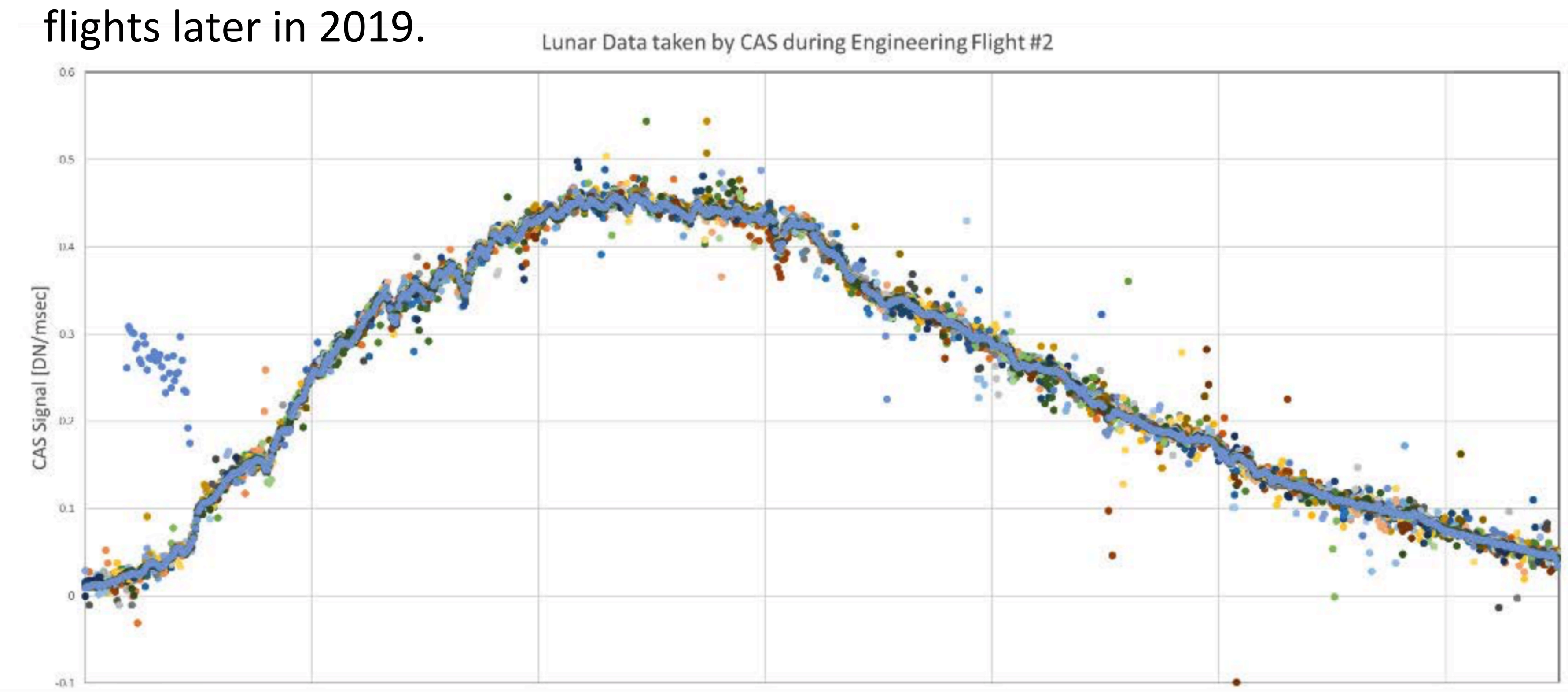
Stat	Error x (px)	Error y (px)	Total Error (px)
count	240 000	240 000	240 000
mean	-0.43	0.32	0.91
std dev	0.61	0.78	0.66
min	-5.00	-5.00	0.00
max	6.00	4.00	6.32

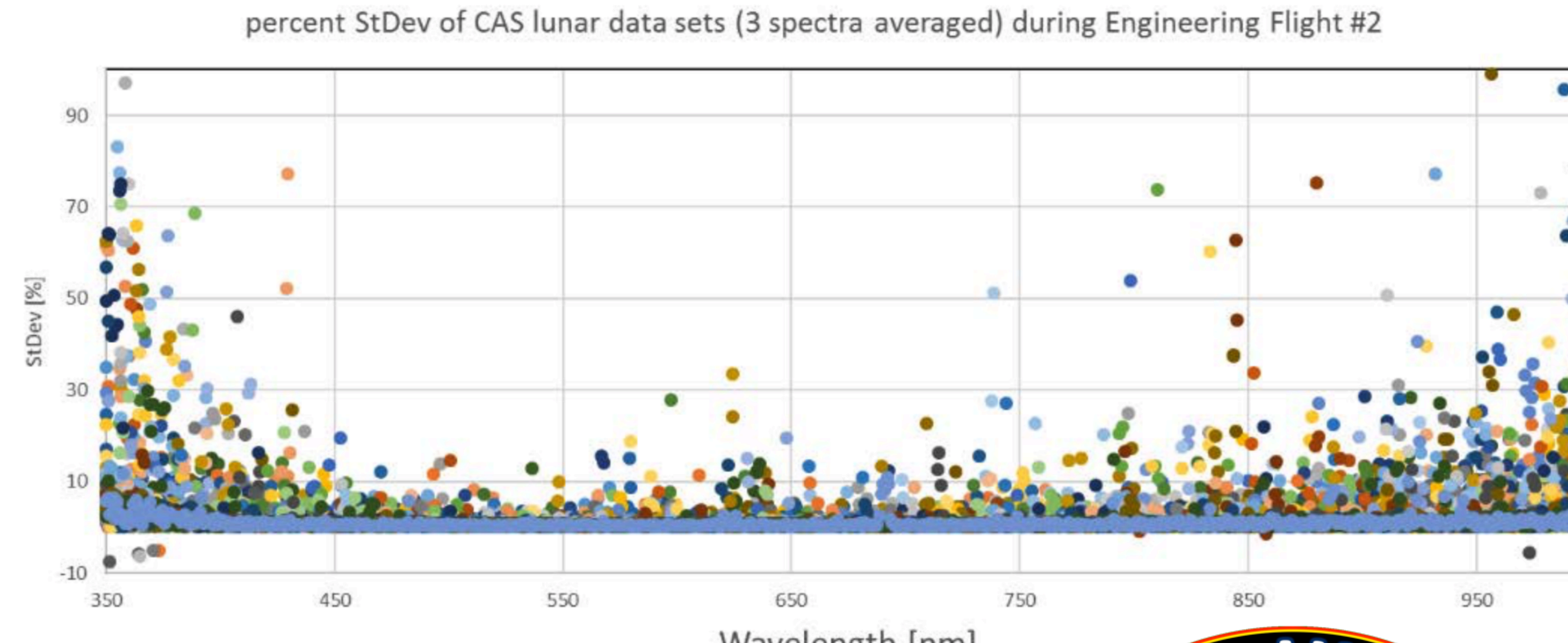
ARTEMIS TRACKING

The ARTEMIS feedback control algortihm finds the centroid of the lunar image and determines the distance from the FOV center (i.e., the tracking error). The computer uses that information to command the actuators to correct the telescope direction. Tracking errors duriing the engineering test flight held between 0 and 1 pixels, which equates to <0.1° accuracy.

3. ENGINEERING FLIGHTS

After a year of design and development, air-LUSI executed its first test flight at AFRC in Palmdale, CA Aug 1st and 2nd between the hours of 0300 and 0500 (UTC-7). The results exceeded expectations. During its test flights, the ARTEMIS subsystem kept the IRIS telescope locked onto the Moon to within 0.1° on average and the IRIS enclosure kept the spectrometer and validation reference solidly at sea-level pressure and constant temperature. The measurements recorded during these flights showed high signal-to-noise ratio and sensitivity to the lunar spectrum. The air-LUSI team is now analyzing these retults and the engineering data and preparing for their demonstration flights later in 2019.





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